

A SCOUT-CLASS LANDER FOR STUDYING GEOPHYSICS AND METEOROLOGY ON MARS

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Introduction. In response to the 2006 Mars Scout AO, a mission proposal was developed for a landed mission to investigate the deep interior, near-subsurface and atmospheric boundary layer (ABL) of Mars. This mission, call the Geophysics and Environmental Monitoring Station (GEMS) would provide key information for a host of previously unaddressed high-priority science questions on Mars using a spacecraft based on the thrice-successful Mars Pathfinder/Mars Exploration Rover (MER) flight system. Cost and risk were minimized by rigorously adhering to three principles: 1) Minimize changes to the proven flight system; 2) Constrain science requirements to fit within the existing flight system limits; and 3) Offset payload costs through extensive teaming with international partners.

Science Justification and Objectives. It is well known that multiple landers making simultaneous measurements (i.e., a network mission) are required to fully address the scientific goals of exploring the interior and lower atmosphere dynamics of Mars. Such missions have proven extremely costly, and so measurements constraining the structure and processes of the deep interior, shallow subsurface, and atmospheric boundary layer (ABL) are as yet virtually nonexistent. However a single station on the surface of Mars can provide groundbreaking measurements resulting in a significant leap in our understanding of these unexplored areas using analysis techniques specific to a single station. These techniques can provide strong constraints on crustal thickness, mantle structure, core size, heat flow, near-subsurface structure and atmospheric processes, providing the first real look beneath the surface of Mars and a comprehensive understanding of the dynamics of the ABL.

Payload. GEMS would carry an ambitious payload, largely supplied by international team members, that would explore the subsurface of Mars at depth scales ranging from a few meters to hundreds of meters to thousands of km, and ABL dynamics from the surface to a height of several km. The instrumentation would include a VBB (Very Broad Band) 3-axis seismometer, an X-band/UHF telemetry system for precision tracking, a panoramic camera (identical to that flown on MER), a pair of penetrating moles to carry strings of thermistors to 3-4 m depth for heat flow measurement, a 2 MHz steerable-beam ground-penetrating radar, and a suite of sensors to simultaneously measure pressure, temperature structure and dust loading (on the surface, on an instrumented mast, and higher in the atmosphere using the camera and an up-looking thermal infrared radiometer), wind and wind shear, and humidity. To provide direct access to the surface for the seismometer and heat flow probes, an articulated mechanical arm would also be included.

Flight System. The flight system would be very close to the that of the MER landers, reverting to the Mars Pathfinder configuration by eliminating the mobility systems. No additional requirements over the existing design were placed the spacecraft systems (i.e., on mass, volume, communication, landing site parameters, etc.) with one notable exception: Instead of the 90-sol surface mission for MER, GEMS would require a design surface lifetime of ½ Mars year (with a desire for a full Mars year) in order to achieve its science objectives. This in turn would require additional reliability engineering and testing.

Mission Operations. After a command-intensive period after landing during which initial deployments and checkouts are accomplished, operations would revert to a near-routine observation mode. Most measurements could be automated, requiring minimal intervention from the Earth.